PHYS 684.1
October 29, 2003

Homework #6

Due: November the 5th.

1. Read Edwards & Syphers section 4.2, 4.3.1 and 4.3.2.

2. Consider a unit square in the tune diagram (i.e. Q_x vs Q_y) with corners at (n, n), $(n+1, n)$, $(n, n+1)$, and $(n+1, n+1)$. On graph paper or with a computer program, draw the lines representing all sum resonances $iQ_x + jQ_y = k$ through fourth order (that means $i + j \leq 4$ for i and j positive integers or zero, k is any integer). Do the same for all difference resonances $iQ_x - jQ_y = k$. Where are the largest areas of the tune space that are resonance-free?

3. Go to the PHY 684 home page and investigate particle motion under a computational model of the "henon map", very similar to a single nonlinear sextupole kick used for chromaticity compensation and slow resonant extraction:

   `http://www.agsrhichome.bnl.gov/AP/Java/henon.html`

   There are two parameters that can be adjusted, the tune Q and the sextupole strength b_2. (A typical good number of iterations is 1000.) Clicking randomly on various points will launch particles through this map, demonstrating areas of regular contour-like motion near the center surrounded by areas of unbounded unstable motion. Now perform the following numerical experiment to investigate the character of the stable region as Q and b_2 are varied.

   (a) Devise a convenient measure of the size of the stable region, and define it quantitatively. (There are many ways to do this.)

   (b) Set b_2 to some convenient moderately large value, 0.3 to 0.4. With this held fixed, plot the size of the stable region as Q is varied from 0.0 to 0.5. At which tunes is motion least stable?

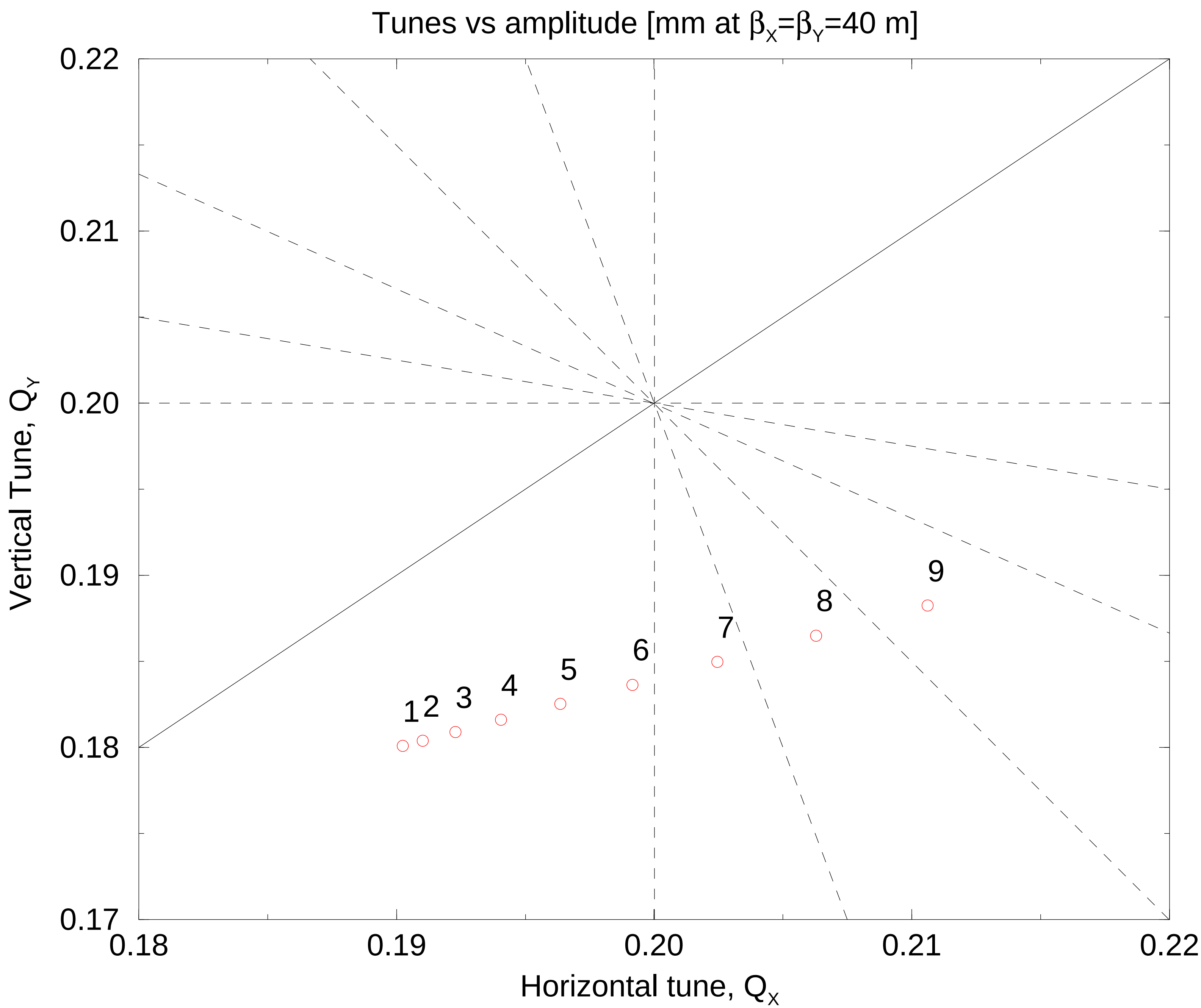
   (c) How is the behavior above $Q = 0.5$ related to behavior below $Q = 0.5$, and why? Describe the behavior near $Q = 0$ as well.

   (d) Now hold Q constant near 1/3, and plot the size of the observed stable region as you vary the sextupole strength b_2. How does this dependency scale?

4. Analyze the simulated tracking data attached as follows:

   a) Plot Q_x and Q_y vs J, using a computer or graph paper, and roughly estimating tune values from the picture. Assume that the numbers given on the plot correspond to the horizontal amplitude in mm and are given at a location where $\beta = 40$ m.

   b) What is your simplest fit to this tune vs action data? Take a guess at what the dominant nonlinearity might be.


Tunes vs amplitude [mm at βX=βY=40 m]
Vertical Tune, QY
Horizontal tune, QX
0.17
0.18
0.19
0.20
0.21
0.22
0.18
0.19
0.20
0.21
0.22
1
2
3
4
5
6
7
8
9